

**BEFORE THE
PUBLIC SERVICE COMMISSION OF
SOUTH CAROLINA**

DOCKET NO. 2020-1-E

In the Matter of)	
Annual Review of Base Rates)	DIRECT TESTIMONY OF
For Fuel Costs for)	KEVIN HOUSTON FOR
Duke Energy Progress, LLC)	DUKE ENERGY PROGRESS, LLC
)	

1 **Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.**

2 A. My name is Kevin Y. Houston and my business address is 526 South Church Street, Charlotte,
3 North Carolina.

4 **Q. BY WHOM ARE YOU EMPLOYED AND IN WHAT CAPACITY?**

5 A. I am the Manager of Nuclear Fuel Supply for Duke Energy Progress, LLC (“DEP” or the
6 “Company”) and Duke Energy Carolinas, LLC (“DEC”).

7 **Q. WHAT ARE YOUR PRESENT RESPONSIBILITIES AT DEP?**

8 A. I am responsible for nuclear fuel procurement for the nuclear units owned and operated by
9 DEC and DEP.

10 **Q. PLEASE SUMMARIZE YOUR EDUCATIONAL BACKGROUND AND**
11 **PROFESSIONAL EXPERIENCE.**

12 A. I graduated from the University of Florida with a Bachelor of Science degree in Nuclear
13 Engineering, and from North Carolina State University with a Master’s degree in Nuclear
14 Engineering. I began my career with the Company in 1992 as an engineer and worked in
15 Duke Energy's nuclear design group where I performed nuclear physics roles. I assumed my
16 current role having commercial responsibility for purchasing uranium, conversion services,
17 enrichment services, and fuel fabrication services in 2012.

18 I served as Chairman of the Nuclear Energy Institute’s Utility Fuel Committee, an
19 association aimed at improving the economics and reliability of nuclear fuel supply and use.

20 I became a registered professional engineer in the state of North Carolina in 2003.

21 **Q. HAVE YOU TESTIFIED BEFORE THIS COMMISSION IN ANY PRIOR**
22 **PROCEEDINGS?**

1 A. Yes, I testified in DEP's 2018 fuel costs proceeding in Docket No. 2018-1-E and DEP's 2019
2 fuel costs proceeding in Docket No. 2019-1-E.

3 **Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY IN THIS PROCEEDING?**

4 A. The purpose of my testimony is to (1) provide information regarding DEP's nuclear fuel
5 purchasing practices, (2) provide costs for the March 1, 2019 through February 29, 2020
6 review period ("review period"), and (3) describe changes forthcoming for the July 1, 2020
7 through June 30, 2021 billing period ("billing period").

8 **Q. YOUR TESTIMONY INCLUDES TWO EXHIBITS. WERE THESE EXHIBITS**
9 **PREPARED BY YOU OR AT YOUR DIRECTION AND UNDER YOUR**
10 **SUPERVISION?**

11 A. Yes. These exhibits were prepared at my direction and under my supervision, and consist of
12 Houston Exhibit 1, which is a Graphical Representation of the Nuclear Fuel Cycle, and
13 Houston Exhibit 2, which sets forth the Company's Nuclear Fuel Procurement Practices.

14 **Q. PLEASE DESCRIBE THE COMPONENTS THAT MAKE UP NUCLEAR FUEL.**

15 A. In order to prepare uranium for use in a nuclear reactor, it must be processed from an ore to a
16 ceramic fuel pellet. This process is commonly broken into four distinct industrial stages: 1)
17 mining and milling; 2) conversion; 3) enrichment; and 4) fabrication. This process is
18 illustrated graphically in Houston Exhibit 1.

19 Uranium is often mined by either surface (i.e., open cut) or underground mining
20 techniques, depending on the depth of the ore deposit. The ore is then sent to a mill where it
21 is crushed and ground-up before the uranium is extracted by leaching, the process in which
22 either a strong acid or alkaline solution is used to dissolve the uranium. Once dried, the
23 uranium oxide ("U₃O₈") concentrate – often referred to as yellowcake – is packed in drums

1 for transport to a conversion facility. Alternatively, uranium may be mined by in situ leach
2 (“ISL”) in which oxygenated groundwater is circulated through a very porous ore body to
3 dissolve the uranium and bring it to the surface. ISL may also use slightly acidic or alkaline
4 solutions to keep the uranium in solution. The uranium is then recovered from the solution in
5 a mill to produce U_3O_8 .

6 After milling, the U_3O_8 must be chemically converted into uranium hexafluoride
7 (“ UF_6 ”). This intermediate stage is known as conversion and produces the feedstock required
8 in the isotopic separation process.

9 Naturally occurring uranium primarily consists of two isotopes, 0.7% Uranium-235
10 (“U-235”) and 99.3% Uranium-238. Most of this country’s nuclear reactors (including those
11 of the Company) require U-235 concentrations in the 3-5% range to operate a complete cycle
12 of 18 to 24 months between refueling outages. The process of increasing the concentration
13 of U-235 is known as enrichment. Gas centrifuge is the primary technology used by the
14 commercial enrichment suppliers. This process first applies heat to the UF_6 to create a gas.
15 Then, using the mass differences between the uranium isotopes, the natural uranium is
16 separated into two gas streams, one being enriched to the desired level of U-235, known as
17 low enriched uranium, and the other being depleted in U-235, known as tails.

18 Once the UF_6 is enriched to the desired level, it is converted to uranium dioxide
19 powder and formed into pellets. This process and subsequent steps of inserting the fuel pellets
20 into fuel rods and bundling the rods into fuel assemblies for use in nuclear reactors is referred
21 to as fabrication.

22 **Q. PLEASE PROVIDE A SUMMARY OF DEP’S NUCLEAR FUEL PROCUREMENT**
23 **PRACTICES.**

1 A. As set forth in Houston Exhibit 2, DEP's nuclear fuel procurement practices involve
2 computing near and long-term consumption forecasts, establishing nuclear system inventory
3 levels, projecting required annual fuel purchases, requesting proposals from qualified
4 suppliers, negotiating a portfolio of long-term contracts from diverse sources of supply, and
5 monitoring deliveries against contract commitments.

6 For uranium concentrates, conversion, and enrichment services, long-term contracts
7 are used extensively in the industry to cover forward requirements and ensure security of
8 supply. Throughout the industry, the initial delivery under new long-term contracts
9 commonly occurs several years after contract execution. DEP relies extensively on long-
10 term contracts to cover the largest portion of its forward requirements. By staggering long-
11 term contracts over time for these components of the nuclear fuel cycle, DEP's purchases
12 within a given year consist of a blend of contract prices negotiated at many different periods
13 in the markets, which has the effect of smoothing out DEP's exposure to price volatility.
14 Diversifying fuel suppliers reduces DEP's exposure to possible disruptions from any single
15 source of supply. Due to the technical complexities of changing fabrication services suppliers,
16 DEP generally sources these services to a single domestic supplier on a plant-by-plant basis
17 using multi-year contracts.

18 **Q. PLEASE DESCRIBE DEP'S DELIVERED COST OF NUCLEAR FUEL DURING**
19 **THE REVIEW PERIOD.**

20 A. Staggering long-term contracts over time for each of the components of the nuclear fuel cycle
21 means DEP's purchases within a given year consist of a blend of contract prices negotiated at
22 many different periods in the markets. DEP mitigates the impact of market volatility on the
23 portfolio of supply contracts by using a mixture of pricing mechanisms. Consistent with its

1 portfolio approach to contracting, DEP entered into several long-term contracts during the
2 review period.

3 DEP's portfolio of diversified contract pricing yielded an average unit cost of \$47.93
4 per pound for uranium concentrates during the review period, representing an increase of 16%
5 per pound from the prior review period.

6 A majority of DEP's enrichment purchases during the review period were delivered
7 under long-term contracts negotiated prior to the review period. The staggered portfolio
8 approach has the effect of smoothing out DEP's exposure to price volatility. The average unit
9 cost of DEP's purchases of enrichment services during the review period decreased 15% to
10 \$79.43 per Separative Work Unit.

11 Delivered costs for fabrication and conversion services have a limited impact on the
12 overall fuel expense rate given that the dollar amounts for these purchases represent a
13 substantially smaller percentage – 18% and 6%, respectively, for the fuel batches recently
14 loaded into DEP's reactors – of DEP's total direct fuel cost relative to uranium concentrates
15 or enrichment, which are 42% and 34%, respectively.

16 **Q. PLEASE DESCRIBE THE LATEST TRENDS IN NUCLEAR FUEL MARKET**
17 **CONDITIONS.**

18 A. Prices in the uranium concentrate markets remain relatively low due to reduced demand
19 following the March 2011 event at Fukushima. Production levels have begun to decrease and
20 industry consultants, believe market prices will need to increase from current levels in order
21 to provide the economic incentive for the exploration, mine construction, and production
22 necessary to support future industry uranium requirements.

1 For conversion services, market prices have continued to increase during the test
2 period.

3 Market prices for enrichment services have begun to rebound as demand has returned
4 to the market following the Fukushima event.

5 Fabrication is not a service for which prices are published; however, industry
6 consultants expect fabrication prices will continue to generally trend upward.

7 **Q. WHAT CHANGES DO YOU SEE IN DEP'S NUCLEAR FUEL COST IN THE**
8 **BILLING PERIOD?**

9 A. The Company anticipates a slight increase in nuclear fuel costs on a cents per kilowatt hour
10 ("kWh") basis through the next billing period. Because fuel is typically expensed over two
11 to three operating cycles (roughly three to six years), DEP's nuclear fuel expense in the
12 upcoming billing period will be determined by the cost of fuel assemblies loaded into the
13 reactors during the review period, as well as prior periods. The fuel residing in the reactors
14 during the billing period will have been obtained under historical contracts negotiated in
15 various market conditions. Each of these contracts contribute to a portion of the uranium,
16 conversion, enrichment, and fabrication costs reflected in the total fuel expense.

17 The average fuel expense is expected to increase from 0.612 cents per kWh incurred
18 in the review period, to approximately 0.622 cents per kWh in the billing period.

19 **Q. WHAT STEPS IS DEP TAKING TO PROVIDE STABILITY IN ITS NUCLEAR**
20 **FUEL COSTS AND TO MITIGATE PRICE INCREASES IN THE VARIOUS**
21 **COMPONENTS OF NUCLEAR FUEL?**

22 A. As I discussed earlier and as described in Houston Exhibit 2, for uranium concentrates,
23 conversion, and enrichment services, DEP relies extensively on staggered long-term contracts

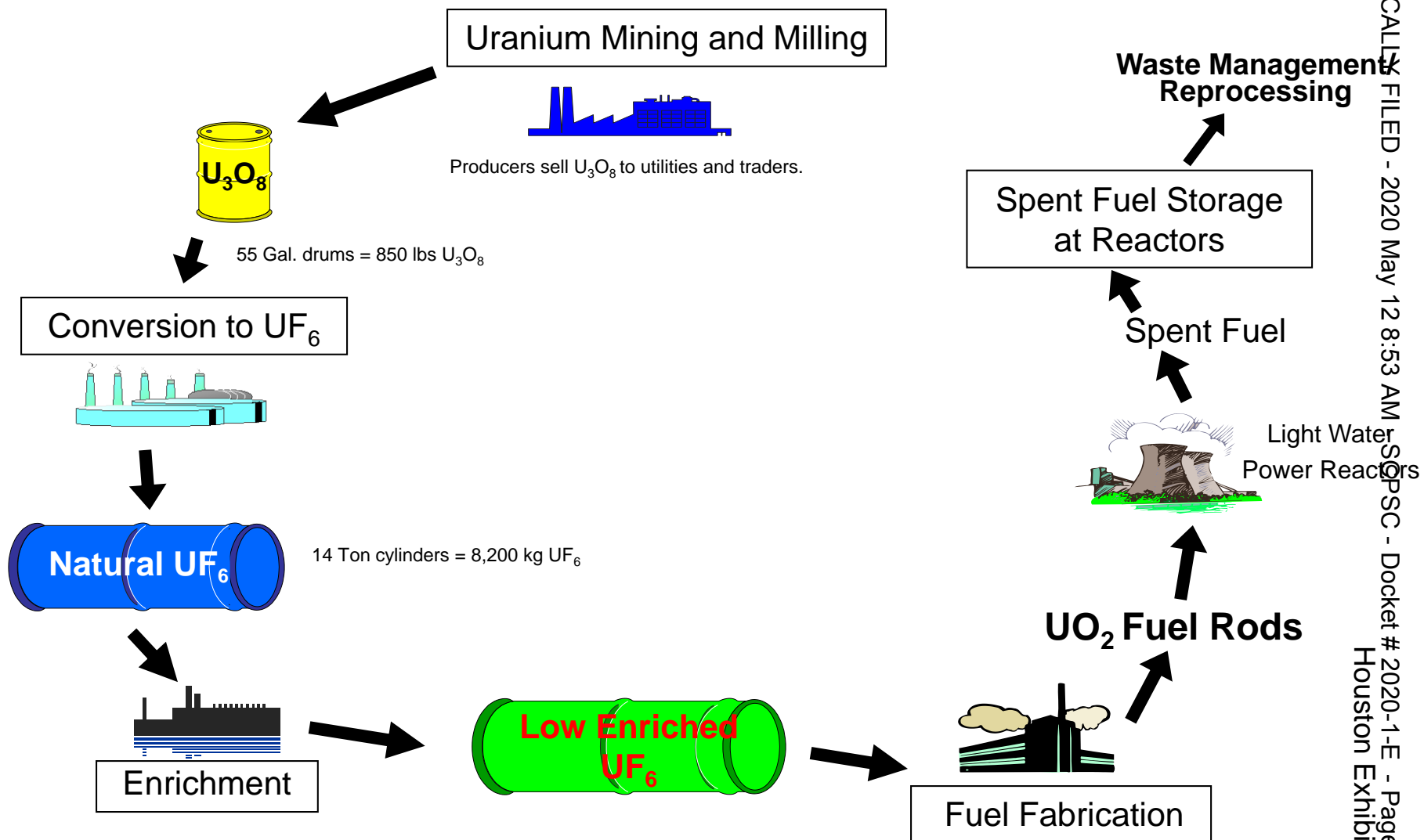
1 to cover the largest portion of its forward requirements. By staggering long-term contracts
2 over time and incorporating a range of pricing mechanisms, DEP's purchases within a given
3 year consist of a blend of contract prices negotiated at many different periods in the markets,
4 which has the effect of smoothing out DEP's exposure to price volatility.

5 Although costs of certain components of nuclear fuel are expected to increase in future
6 years, nuclear fuel costs on a cents per kWh basis will likely continue to be a fraction of the
7 cents per kWh cost of fossil fuel. Therefore, customers will continue to benefit from DEP's
8 diverse generation mix and the strong performance of its nuclear fleet through lower fuel costs
9 than would otherwise result absent the significant contribution of nuclear generation to
10 meeting customers' demands.

11 **Q. DOES THIS CONCLUDE YOUR PRE-FILED DIRECT TESTIMONY?**

12 **A.** Yes, it does.

The Nuclear Fuel Cycle



Houston Exhibit 2**Duke Energy Progress, LLC Nuclear Fuel Procurement Practices**

The Company's nuclear fuel procurement practices are summarized below:

- Near and long-term consumption forecasts are computed based on factors such as: nuclear system operational projections given fleet outage/maintenance schedules, adequate fuel cycle design margins to key safety licensing limitations, and economic tradeoffs between required volumes of uranium and enrichment necessary to produce the required volume of enriched uranium.
- Nuclear system inventory targets are determined and designed to provide: reliability, insulation from market volatility, and sensitivity to evolving market conditions. Inventories are monitored on an ongoing basis.
- On an ongoing basis, existing purchase commitments are compared with consumption and inventory requirements to ascertain additional needs.
- Qualified suppliers are invited to make proposals to satisfy additional or future contract needs.
- Contracts are awarded based on the most attractive evaluated offer, considering factors such as price, reliability, flexibility and supply source diversification/portfolio security of supply.
- For uranium concentrates, conversion and enrichment services, long term supply contracts are relied upon to fulfill the largest portion of forward requirements. By staggering long-term contracts over time, the Company's purchases within a given year consist of a blend of contract prices negotiated at many different periods in the markets, which has the effect of smoothing out the Company's exposure to price volatility. Due to the technical complexities of changing suppliers, fabrication services are generally sourced to a single domestic supplier on a plant-by-plant basis using multi-year contracts.
- Spot market opportunities are evaluated from time to time to supplement long-term contract supplies as appropriate based on comparison to other supply options.
- Delivered volumes of nuclear fuel products and services are monitored against contract commitments. The quality and volume of deliveries are confirmed by the delivery facility to which the Company has instructed delivery. Payments for such delivered volumes are made after the Company's receipt of such delivery facility confirmations.